Care Coordination and Electronic Health Records: Connecting Clinicians

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Abstract

Objective*: To examine the association between use of electronic health records (EHR) and care coordination.*

Study Design: *Two surveys, in 2005 and again in 2006, of primary care clinicians working in a prepaid integrated delivery system during the staggered implementation of an EHR system. Using multivariate logistic regression to adjust for clinician characteristics, we examined the association between EHR use and clinicians' perceptions of three dimensions of care coordination: timely access to complete information; treatment goal agreement; and role/responsibility agreement.*

Results: *Compared to clinicians without EHR, clinicians with 6+ months of EHR use more frequently reported timely access to complete information, and being in agreement on treatment goals with other involved clinicians. There was no significant association between EHR use and being in agreement on roles and responsibilities with other clinicians.*

Conclusions: *EHR use is associated with aspects of care coordination involving information transfer and communication of treatment goals.*

INTRODUCTION

The number of Americans living with at least one chronic condition is large and growing. In 2005, almost half of all Americans had at least one chronic condition and one in four had multiple[1]. These patients typically see multiple providers per year and have numerous prescription drugs[1]. Care for these patients is becoming increasingly complex and requires a high level of coordination to ensure quality care[2]. The implementation of an Electronic Health Records (EHR) system could be key in facilitating the transfer of information and improving coordination of patient care across multiple clinicians[2-5]. While EHR systems have been consistently promoted as a policy priority for improving the quality and efficiency of the American healthcare system[4], there is still limited research evidence to inform policy-makers about the effects of EHR systems on care coordination.

Existing evidence indicates that clinicians rarely have access to complete medical information when patient care is transferred across providers and that patient safety may be jeopardized during these transitions in care[2,6-8]. Lack of timely information often results in inadequate patient monitoring, redundant care, medical errors[9-11], or greater use of hospital and emergency services[12]. Any practical realization of a model for coordinated care must rely heavily on the timely availability of comprehensive clinical information, likely provided through an integrated EHR system. Integrated EHR systems, which compile a comprehensive patient clinical record, have clear potential to significantly improve the coordination of clinical care delivery by improving the availability and timeliness of patient's medical information[13-18].

In this study, we investigate the impact of implementing a commercially available, integrated EHR system on multiple measures of care coordination. Using primary care clinician surveys collected in 2005 and 2006, we investigate the association between use of EHR and three clinician reported measures of care coordination: 1) availability and timeliness of relevant medical information; 2) agreement on treatment goals and plans among a patient's clinicians; 3) and agreement on roles and responsibilities among clinicians.

METHODS

Study Setting

This study was conducted at Kaiser Permanente Northern California (KPNC), a large prepaid Integrated Delivery System (IDS) providing comprehensive medical care for over three million members. Primary care clinicians worked in the Internal Medicine and Family Medicine departments and were grouped in 110 primary care teams, across 18 Medical Centers.

Health Information Technology (HIT)

While HIT can encompass many types of systems, according to the Institute of Medicine (IOM), a

complete EHR system consists of eight integrated core functions, including health information, results management, order entry and management, decision support, electronic communication, patient support, population management, and administrative support[5]. The EHR is designed to completely replace paper-based medical charts and paper-based ordering of prescription medications and clinical laboratory tests[5].

In February 2005, the IDS began a multi-year staggered implementation of a commercially available, integrated EHR system across its 18 medical centers. Implementation of the ambulatory system was completed throughout the IDS in the spring of 2008. The ambulatory EHR system was rolled out by medical center, and staggered by primary care team within each medical center. At the time of the first survey (2005), less than two percent of respondents were using the integrated EHR system. In 2006, over sixty percent of respondents had started using the EHR system. Once implemented, the EHR system completely replaced the paper medical record.

Prior to the deployment of the integrated EHR system in early 2005, there was already a patchwork of non-integrated HIT applications available to primary care clinicians working in the IDS. While these earlier applications provided some helpful functions (e.g., documentation, order-entry, laboratory test results, and visits), these HIT applications did not include all of the required components of an EHR system and were not integrated, meaning that the provider had to log onto each application separately, and information was not automatically updated from one application to the next. Use of these early HIT applications was voluntary, as paper-based medical charts and paper-based alternatives for completing many of the same functions were still in use.

Survey Collection

In 2005 and 2006, we mailed a self-administered questionnaire to all adult primary care clinicians working in the IDS. Each clinician received a letter introducing the study, a copy of the survey, and a pre-paid return envelope. Respondents who completed the survey received a $5 gift card. Non-respondents were re-sent reminder letters and surveys up to four times.

Population

We surveyed all adult primary care clinicians working in the IDS in 2005 and 2006, including physicians, nurse practitioners and physician assistants. We excluded clinicians who did not have an active panel of patients. After this exclusion, the study population included 1028 physicians and 129 nurse practitioners and physician assistants in 2005; and 984 physicians and 107 nurse practitioners and physician assistants in 2006. Overall, 565 primary care clinicians responded in 2005 (48.1% response rate) and 678 in 2006 (61.5% response rate); 396 clinicians responded in both 2005 and 2006.

Survey Instrument

On the survey, we asked primary care clinicians about four specific aspects of care coordination. We asked: "How often does each of the following occur when care is transferred across clinicians (e.g. from a specialist to the primary care team)?" The response categories were: never, rarely, sometimes, usually, and always.

1. "All relevant medical information is available."
2. "The information transfer is timely, i.e. available when it is needed."
3. "All clinicians agree on the treatment goals and plans."
4. "All clinicians agree on roles and responsibilities of each party."

We also asked clinicians about their EHR use for eight specific clinical activities during their patient visits. In addition, the survey collected several respondent characteristics, including race/ethnicity, gender, job title, and hours worked per week. Questions on care coordination and EHR use were developed by an expert panel of scientific advisors specifically for use in this study. All questions were pre-tested for clarity. We supplemented survey response with information obtained from the IDS' automated database on clinician characteristics, including age, gender, panel size, job title, and race/ethnicity.

Data Analysis

Outcome measures

We have three types of clinician reported care coordination measures: timely access to complete information, agreement on treatment goals and plans among a patient's clinicians, and agreement on roles and responsibilities among clinicians. For the first measure, timely access to complete information, we created a dichotomous outcome variable which combined responses to the survey questions asking if 'all relevant medical information is available' and 'information transfer is timely'. Since the responses to the two original survey questions were highly correlated (.77), this combined variable is equal to one if the respondent reported 'always' or 'usually' to both questions, otherwise it was coded as zero. Further, we reasoned that in order for information to

be useful when coordinating care, it must be both complete and timely.

For the two coordination agreement questions, we created two separate dichotomous variables called "agreement on treatment goals and plans" and "agreement on roles and responsibilities"; each was coded as a one if to the clinician responded the relevant agreement 'always' or 'usually' occurs, otherwise it was coded as a zero.

For all coordination questions, over 80% of responses were split between the 'sometimes' and 'usually' response options, therefore we found it reasonable to dichotomize responses to make the results easier to interpret. The number of missing values was small (<5%) and not correlated with EHR status, therefore missing responses were dropped from the analyses.

Predictor measures

The main independent variable of interest is availability and use of the integrated EHR. The primary definition of EHR use was defined using the IDS' automated data, which captured the source of diagnoses (pre-EHR data system vs. EHR). Once the EHR was installed at a primary care team site, use of EHR by members of the primary care team reached 80% of visits within a month. Since availability of EHR may have varied during the installation transition period, we defined clinicians as having access to EHR when over 80 percent of visits made by their primary care team were entered using the EHR system. In order to capture any variation in the effects of EHR use over time (e.g., learning curve), the post-EHR group was divided into two periods: less than six months, and more than six months post-EHR (range 7-20 months).

Since the automated data captured only a summary measure of any EHR use, we included a survey measure of consistency of HIT use (either pre-EHR data system or EHR) across many specific clinical functions as a covariate in the multivariate models. We defined clinicians as having 'systematic HIT use' if they reported using HIT for data-review (viewing laboratory test results, current list of medications, and drug allergies), order-entry (transmitting prescribed medications to the pharmacy), communication (sending messages to other clinicians or requesting referrals/consultations), and documentation (entering visit notes using either free text or templates) for 80% or more of their patient visits.

Model

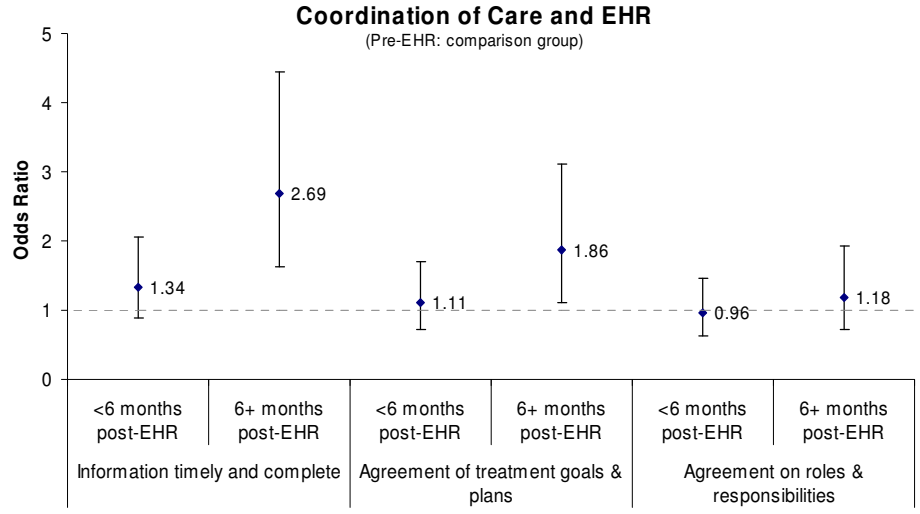
To analyze the effect of using the integrated EHR system on care coordination, we used a generalized estimating equation (GEE) method with a logistic model to account for clustering by clinicians. We included the following clinician characteristics as covariates: age, gender, race/ethnicity (white vs. non-white), job title (physicians vs. nurse practitioners and physician assistants), self-reported hours worked (full vs. part-time), and systematic HIT use. For covariates with missing responses (5.6% for systematic HIT use and 15.4% for hours worked per week), we included a separate category for missing responses. We also included a year indicator variable to control for time trends that may have affected the dependent variables but were unrelated to the implementation of EHR. We included indicator variables for each medical center to control for medical center specific fixed effects. The models presented provide an overall view of the averaged effects of EHR on the three measures of care coordination controlling for a number of variables. We also tried other model specifications, including models with clinician fixed and random effects, and found similar results.

RESULTS

Over a third of respondents (35.9% in 2005 and 38.1% in 2006) were forty years old or younger; 84.3% in 2005 and 88.4% in 2006 were physicians, rather than nurse practitioners; 42.0% in 2005 and 38.5% in 2006 worked fulltime (≥40 hours per week with primary care team); and the average panel size was 1,500 patients in 2005 and 1,525 in 2006. In 2005, most respondents (92.92%) were pre-EHR; by 2006, only 38.1% were pre-EHR, 29.7% had EHR for less than six months, and 32.3% had it for more than six months.

Overall, pooling responses from 2005 and 2006, clinicians who used EHR for longer than six months reported higher coordination than clinicians without EHR (all $p < .005$); 41.3% of clinicians without EHR reported access to timely and complete information compared to 54.6% for those in their first six months post-EHR, and 67.0% after six months of EHR use; 56.6% of clinicians without EHR reported agreement on treatment goals and plans, compared to 61.3% in the first six months post-EHR, and 72.4% after six months of EHR use; and 48.7% of clinicians without EHR reported agreement on roles and responsibilities compared to 55.1% the first six months post-EHR, and 61.8% after six months of EHR use. Systematic HIT use was 22.3% among those pre-EHR and 47.4% after six months of EHR use (all $p < .005$).

Figure 1: Adjusted model of clinician reported care coordination by length of EHR use



Model used: Logistic model with GEE estimation, adjusted for clinician age, race, gender, job title, panel size, survey year, level of Health IT use, and includes medical center fixed effects.

Figure 1 displays the results from multivariate regression analyses of the three coordination items. Clinicians who used EHR for more than six months were significantly more likely to report having access to timely and complete information than those without EHR (OR=2.69; 95%CI: 1.63-4.45); however, there were no significant differences for clinicians who used the EHR for less than six months (OR=1.34, 95%CI: 0.90-2.05). Clinicians who reported systematic HIT use were also more likely to report access to timely and complete information than those without EHR (OR=1.49, 95% CI: 1.11-1.90). We also found significant temporal changes, with clinicians who responded in 2006 substantially more likely to report access to timely and complete information compared with those who responded in 2005 (OR=1.67, 95% CI:1.22-2.29).

Clinicians who used EHR for more than six months were significantly more likely to report agreement on treatment goals and plans than those pre-EHR (OR=1.86, 95%CI: 1.12-3.11); however, there were no significant differences for clinicians who used EHR for less than six months (OR=1.11, 95% CI: 0.73-1.70) or for those who reported systematic HIT use (OR=1.16, 95% CI: 0.88-1.54). Neither period of post-EHR use showed significant differences in clinician agreement on roles and responsibilities; however, those who reported systematic HIT use were significantly more likely to report agreement on roles and responsibilities across all clinicians involved in a patient's care (OR=1.37, 95% CI: 1.05-1.80).

DISCUSSION

We examined the impact of implementing a commercially available, integrated EHR system on three aspects of care coordination: 1) access to timely and complete information; 2) agreement on treatment goals and plans among clinicians; and 3) agreement on roles and responsibilities among clinicians. After adjusting for individual characteristics, we found that clinicians who used EHR for longer than six months were significantly more likely than those with no EHR use to report having timely access to relevant clinical information and having agreement on patient treatment objectives with other treating clinicians. We did not find any significant association between EHR use and having agreement on roles and responsibilities among the treating clinicians. Additionally, use of the EHR for less than six months was not significantly associated with any of the care coordination measures.

One of the principal functions of an EHR system is to provide all clinicians and medical staff involved in a patient's care with current and comprehensive patient health information. As expected, reported timeliness and completeness of relevant clinical information was highly associated with EHR use. In addition, EHR systems allow clinicians to better document the patients' care plans and facilitate communication across multiple clinicians. Therefore, as expected, we found a significant positive effect of EHR use on clinician agreement of treatment goals and plans. Conversely, individual clinician responsibilities are not explicitly documented in most EHR systems, thus we expected the effects of EHR use on clinician agreement of clinician roles and responsibilities to be

minimal. Consistent with this hypothesis, we did not see any significant early improvements in this measure for clinicians who used EHR for less or longer than six months. Whether improved communication leads to clarifications over time about the roles of individual clinicians when multiple clinicians are caring for a patient remains to be seen.

Similarly, while we found significant improvements in coordination associated with EHR use, the total EHR impact may be greater eventually. In 2006, implementation was not yet complete throughout the IDS. Improvements in coordination of care may continue to increase as medical centers and clinicians have more time to adjust to the new system, more clinicians use it systematically, and more medical centers within the IDS complete the implementation of the EHR system.

Finally, the potential for coordination improvement could be larger in other more fragmented settings, especially in situations when there is less patient overlap between clinicians. Beyond EHRs, integrated delivery systems may use a number of other mechanisms to improve care coordination, which is consistent with our finding of improvements in coordination over time that were separate from the EHR effects.

Perceptions of care coordination could differ among other members of a patient's care team including specialists and non-clinician staff. In addition, our outcome variables of care coordination were based on self-reported data, not on an audit of actual information available. It is possible that some clinicians may have reported anticipated benefits of EHR rather than actual levels of achieved care coordination. Still, these clinician-reported coordination measures provided a unique opportunity to examine the effect of EHR use on coordination of care, since audit trails do not provide any measures of care coordination. We are currently working to validate the predictive power of our three care coordination measures on patient outcomes.

In summary, the introduction of the Electronic Health Record system was associated with substantial improvements in clinical *information transfer* and *communication of treatment goals.*

References

(1) Partnership for Solutions and Johns Hopkins University. Chronic Conditions: Making The Case for Ongoing Care. 9-12-2004.

(2) Bodenheimer T. Coordinating care--a perilous journey through the health care system. *N Engl J Med.* 2008;358:1064-1071.

(3) Institute of Medicine. The computer-based patient record: an essential technology for Health Care. 1997.

(4) Institute of Medicine. Crossing the Quality Chasm: A New Health System for the 21st Century. 2001.

(5) Institute of Medicine. Key Capabilities of an Electronic Health Record System: Letter Report. 2003.

(6) Coleman EA, Boult C. Improving the quality of transitional care for persons with complex care needs. *Journal of the American Geriatrics Society.* 2003;51:556-557.

(7) Coleman EA. Falling Through the Cracks: Challenges and Opportunities for Improving Transitional Care for Persons with Continuous Complex Care Needs. *Journal of the American Geriatrics Society.* 2003;51:549-555.

(8) Coleman EA, Berenson RA. Lost in Transition: Challenges and Opportunities for Improving the Quality of Transitional Care. *Annals of Internal Medicine.* 2004;141:533.

(9) Moore C, Wisnivesky J, Williams S, McGinn T. Medical errors related to discontinuity of care from an inpatient to an outpatient setting. *J Gen Intern Med.* 2003;18:646-651.

(10) Elder NC, Meulen MBV, Cassedy A. The Identification of Medical Errors by Family Physicians During Outpatient Visits. *Annals of Family Medicine.* 2004;2:125.

(11) Elder NC, Hickner J. Missing Clinical Information The System Is Down. *Jama.* 2005;293:617-619.

(12) Weiner M, Biondich P. The influence of information technology on patient-physician relationships. *J Gen Intern Med.* 2006;21 Suppl 1:S35-S39.

(13) Hunt DL, Haynes RB, Hanna SE, Smith K. Effects of computer-based clinical decision support systems on physician performance and patient outcomes: a systematic review.[see comment]. *Jama.* 1998;280:1339-1346.

(14) Kaushal R, Shojania KG, Bates DW. Effects of computerized physician order entry and clinical decision support systems on medication safety: a systematic review. *Arch Intern Med.* 2003;163:1409-1416.

(15) Kuperman GJ, Gibson RF. Computer physician order entry: benefits, costs, and issues. *Ann Intern Med.* 2003;139:31-39.

(16) Tierney WM, Miller ME, Overhage JM, McDonald CJ. Physician inpatient order writing on microcomputer workstations. Effects on resource utilization. *Jama.* 1993;269:379-383.

(17) Lobach DF, Hammond WE. Computerized decision support based on a clinical practice guideline improves compliance with care standards. *Am J Med.* 1997;102:89-98.

(18) Chaudhry B, Wang J, Wu S et al. Systematic review: impact of health information technology on quality, efficiency, and costs of medical care. *Ann Intern Med.* 2006;144:742-752.